Photophysical performance of radio frequency sputtered Pt/n-PSi/ZnO NCs/Pt photovoltaic photodetectors

ABSTRACT

The effect of the annealing temperature on the photoelectrical properties of the nanoporous silicon/zinc oxide nanocrystallites-based (Pt/n-PSi/ZnO NCs/Pt) photodetector was investigated. Different morphologies of 3D ZnO were synthesized onto the n-PSi substrates via radio frequency (RF) sputtering in the absence of a catalyst. The synthesis of ZnO NCs was controlled by varying the growth temperature between 600–700 °C and 800–900 °C. The effect of the synthesis temperature on the structural, morphological, and optical properties of the n-PSi/ZnO NCs was systematically studied using field emission scanning electron microscopy (FESEM), X-ray diffraction (XRD), atomic force microscopy (AFM), and photoluminescence spectroscopy (PL) techniques. The roughness was found to be dependent on the anodization current density. The optimal n-PSi/ZnO NCs-based metal-semiconductor-metal UV detector (MSM) was fabricated at 700 °C. The fabricated device showed a high sensitivity of 1007.14, an internal photoconductive gain of 11.07, and a responsivity of 5.99 A/W with a low dark current when illuminated with 380 nm light (1.55 mW/cm2) at +5 V bias voltage. In addition, the response and recovery times were determined to be 0.34 and 0.22 s, respectively. This approach offers a cost-effective substrate and simple synthesis method to improve the growth of the n-PSi/ZnO NCs and demonstrates the successful fabrication of nanoscale photodetectors with potential application in nano-optics devices.

Keyword: RF sputtering; ZnO nanocrystallites; Porous silicon; Annealing temperature; Photodetector